HAER No. NV-29-A

Nevada Test Site, Reactor Maintenance Assembly and Disassembly Facility
(RMAD Building)
(Building No. 3110)
Area 25, Jackass Flats
Junction of Roads F and G
Mercury Vicinity
Nye County
Nevada

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12-MERC.V,
3A-

# PHOTOGRAPHS

# WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Department of the Interior
San Francisco, California

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# HISTORIC AMERICAN ENGINEERING RECORD
# NEVADA TEST SITE, REACTOR MAINTENANCE ASSEMBLY AND DISASSEMBLY FACILITY, BUILDING 3110
# HAER NO. NV-29-A

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| **Location:** | Road G, Jackass Flats, Area 25, Nevada Test Site, Mercury Vicinity, Nye County, Nevada<br><br>USGS Jackass Flats 7.5'<br>UTM Coordinates Zone 11 E 567,930 N 4,074,530 |
| **Dates of Construction:** | 1958 |
| **Engineer:** | Burns & McDonnell Engineering Company, Kansas City, Missouri |
| **Builder:** | Sierra Construction Company, Inc., Las Vegas |
| **Present Owner:** | Department of Energy, Nevada Operations Office<br>P.O. Box 98518, Las Vegas, NV 89193-8518 |
| **Present Occupant:** | Not occupied |
| **Present Use:** | Vacant; no public access; to be demolished |
| **Significance:** | The Reactor Maintenance Assembly and Disassembly facility is significant for its role in the United States space program. The facility was part of the Rover project for the initial development and testing of a nuclear-propelled launch vehicle with goals to orbit Mars, missions to Mercury and Jupiter, and eventually, exploration beyond our solar system. Although the project did not result in an actual flight, it revealed that such missions were technically feasible and the knowledge gained is still part of the space program today. Termination of the Rover project was in 1973. |
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| **Date:** | October 2000 |

## I. CONTEXTUAL INFORMATION

The Reactor Maintenance Assembly and Disassembly (R-MAD) facility was an integral component of the Nuclear Rocket Development Station (NRDS) operations in Area 25 (originally Area 400) of the Nevada Test Site (NTS) (Figures 1-2), originally administered by the Atomic Energy Commission (AEC) and later by the Department of Energy, Nevada Operations Office (DOE/NV). Other major facilities for the NRDS included two test cells (Test Cells A and C), an Engine Maintenance Assembly and Disassembly (E-MAD) facility, an engine test stand (ETS-1), a Reactor Control Point complex, and the Support Area complex. The mission of the NRDS, managed by the Los Alamos Scientific Laboratory (now the Los Alamos National Laboratory), University of California, was to develop and test nuclear rocket engines and reactors during the Rover project for the space program of the United States (AEC 1961a:69; House 1963). The objective in the development of this type of nuclear engine was to enable the United States to undertake long and complicated journeys not possible at the time with existing methods (House 1963; Schreiber 1961:25, 29). The program at the NRDS began in 1957 and ended in 1973 (AEC 1974:23; Beck et al. 1996; Friesen 1995:1; Miller 1984:5). The R-MAD facility has been determined eligible to the National Register of Historic Places through consultation between DOE/NV and the Nevada State Historic Preservation Office and is currently slated to be demolished under the Environmental Management Deactivation and Decommissioning Program (Carlson 1999).

The main purpose of Building 3110 was to assemble nuclear reactors for rockets and then disassemble them after they were tested at one of the test facilities, usually Test Cell A during the earlier phase of the Rover project and Test Cell C during the later phase. Other structures within the R-MAD site complex (Figures 3-5), which encompasses about 53 acres (21 hectares), included a decontamination building (Building 3126) used for decontaminating disassembly tools and the test car, a security station (Building 3112), an electric substation, a large warehouse (Building 3111), Jr. Hot Cell (Building 3161), a locomotive shed (Building 3119), a test, paint, and storage building (Building 3140), a 30,000 gallon water tower, and several storage sheds (Beck et al. 1995; Miller 1984:6, 11; Space Nuclear Propulsion Office 1969:64-66, 106). A relatively isolated 10-acre hot dump was located a short distance southeast of the facility and was connected with it by railroad spurs from the main railroad line that serviced the NRDS facilities. The dump was used for storage and cooling of used test cars, components, and contaminated material. A trestle on one of the railroad spurs allowed for dumping of contaminated waste into a pit below the trestle. Spent fuel was stored on flatcars on a second spur. The "Beetle," a remote-controlled, self-propelled machine built by General Electric (Figure 6), was also housed at the R-MAD complex in Building 3125 and was used at the NRDS for handling exposed radioactive equipment associated with the reactor tests.

Kiwi, Phoebus, NRX, and Peewee test reactors were assembled and disassembled at the R-MAD. The Tory II-C reactor from the Pluto project for the development of nuclear-powered missiles was stored here before transporting it to the E-MAD for disassembly. In 1961, President John F. Kennedy toured the AEC facilities for the purpose of receiving briefings on the Rover project, first in New Mexico at LASL and the Sandia Laboratory and then the NRDS (AEC 1963:172). At the NRDS, he inspected the R-MAD, Test Cell C, and Engine Test Stand No. 1. At the R-MAD he witnessed a portion of the disassembly of the Kiwi B-4A reactor (Figure 7). In the late 1970s after the nuclear rocket program was cancelled, the Ballistic Missile Office of the U.S. Air Force used the R-MAD facility for development and testing of the MX Canister Assembly and Test Launch Program. Structures, e.g., steel towers and camera stations, associated with this program are on the north side of Building 3110 (see Figure 3).

## II. ARCHITECTURAL AND ENGINEERING INFORMATION

Building 3110, the main building of the R-MAD facility, was constructed in 1958 by Sierra Construction Company, Inc. of Las Vegas with Burns & McDonnell Engineering Company, Kansas City, Missouri serving as the engineering firm. The structure is a multi-story conglomerate of concrete and corrugated galvanized metal, and basically, represents an intricate massing of rectangular flat-roofed blocks with attached pipes and vertical stacks. The massing presents no architectural logic, but is driven by the functional requirements of the spaces within. A second large assembly bay along the west side of the building and small hot cells with an associated viewing gallery at the southeast corner were added shortly after the initial construction of the building. Original portions of the building are reinforced concrete, while later additions, e.g., Assembly Bay No. 2, are constructed of concrete masonry units (CMU) and corrugated aluminum.

After several expansions, the building measures 254 ft (77 m) in length, 186 ft (57 m) in width, 63 ft (19 m) in height and contains 61,290 sq ft (5,694 sq m) over full and partial floor levels. The main components are two large assembly bays, a large disassembly bay, post-mortem cells, corridors, a control room, and support offices and shops. It is essentially divided into hot and cold sections based on exposures to radioactive material (Figures 8-12), with the hot section constructed of reinforced concrete six feet thick. Entrance from the outside into the disassembly bay, also referred to as a hot bay, is by the main shielding door that measures 29 ft (8.8 m) high, 26 ft (7.9 m) wide, and 6 ft (1.8 m) thick. The door is made of reinforced concrete and weighs about 400 tons (363 m tons). A second concrete door, weighing about 750 tons (681 m tons) and 5 ft (1.5 m) thick, is inside, separating the hot bay into upper and lower levels. It is from the upper level that parts of the reactor were lowered to the post-mortem cells adjacent to the hot bay for further disassembly. Disassembly activities were viewed from corridors surrounding the hot bay and post-mortem cells through six feet thick windows, comprised of layered leaded glass panes immersed in mineral oil, and had the same shielding capabilities as the walls. The larger viewing windows when assembled weighed about six tons (5.4 m tons). Nearly all of them have been removed, as have most of the manipulator arms, and these were used at the E-MAD facility and elsewhere. Construction of the cold section is dramatically different compared to the hot section, with mostly corrugated metal and concrete block, and includes the assembly bays, boiler and air conditioning rooms, engineering offices, and shops. The engineering offices were on the second floor above the laboratory and storage rooms. No equipment or furniture remain in the shops or offices. Reactors were assembled in the cold assembly area prior to being taken to the test cells and tested.

The south elevation serves as the primary facade and the front of the building (Photographs 1-2). The original portions are at the east end, while newer portions are at the west. This south elevation presents masses of varying height, with lower masses toward the front (south), stepping back to higher masses toward the rear (north). Openings are few, and include personnel and rolling metal equipment doors. At approximately the center of the elevation is a pair of glazed metal doors known commonly as the "Kennedy Doors" (Photograph 3). President John F. Kennedy was photographed here during his brief visit to the NRDS in the early 1960s.

The west elevation consists of the tall corrugated aluminum side wall of Assembly Bay No. 2 to the north and the lower CMU extension to the south (Photographs 4-5). The assembly bay west wall is blank except for a 12 x 20 ft (3.7 x 6.1 m) rolling metal equipment door and a hollow metal personnel access door. The CMU portion features an 8 x 8 ft (2.4 x 2.4 m) rolling metal door at the south end, and three high windows, which illuminate the engineering offices at the addition's second floor.

Tall facades of the three high bays dominate the north elevation (Photographs 5-7). The hot disassembly bay is at the east end, crowned by a soaring metal chimney stack. At the west end is the corrugated metal addition, Assembly Bay No. 2. Alongside it to the east is Assembly Bay No. 1 constructed of concrete. Both of the cold assembly bays feature large rolling metal equipment doors, while the door for the Disassembly Bay is made of reinforced concrete. Railroad tracks enter through each of the high bay equipment doors.

The east elevation presents a complex concrete mass with a CMU element/addition at the south end (Photographs 7-9). A high, central concrete tower element dominates the facade at its center. A tall metal chimney stack, a feature of the north elevation, is visible at the elevation's north end. Walls are mostly blank. Minimal openings include awning windows, just north of the tower, and double access doors, south of the tower. Two staircases, enclosed by metal pipe rails, descend to the basement.

The primary north-south oriented corridor (Room 116) of the administrative area has vinyl asbestos tile (VAT) floors, reinforced concrete walls, and a suspended acoustical ceiling with strip fluorescent lighting (Photograph 10). The suspended ceiling and lighting was in the process of being removed. Duct work and concrete waffle slab structure are visible above the ceiling fragments. At the south end of the corridor is Room 120, a vestibule and double doors accessing the outside. These are the "Kennedy Doors" mentioned above. A series of small offices are along the east wall and include Rooms 160 (Photograph 11), 114-115, and 117-119. These small administrative spaces include VAT floors, concrete walls, and 2 x 4 ft acoustical tile ceilings. Strip fluorescent fixtures light the rooms. The north end of the corridor terminates in a restroom (Photograph 12). Centered at the east side of the corridor is a concrete ramp that leads up to the disassembly bay area. The ramp features concrete walls, an abated VAT floor, and metal supports remaining from a 2 x 4 ft acoustical tile ceiling.

The assembly area (see Figure 8) dates from separate periods of construction. Assembly Bay No. 1, the service entry, boiler room, machine shop and electrical room date from the initial building construction, while Assembly Bay No. 2, reactor control lab, core storage and assembly room, and the second floor engineering offices date from a later construction period. The assembly bays were used for reactor core assembly and mechanical coupling of the reactor to the test car. Both bays were served by 5- and 15-ton overhead bridge cranes. In addition, special experiments such as the heat exchanger were fabricated there.

Assembly Bay No. 1 (Room 101) is a high rectangular space contained by a concrete floor, walls, and ceiling (Photograph 13). It is about 75 ft (23 m) long, 45 ft (14 m) wide, and 48 ft (15 m) high. Walls feature structural concrete pilasters. Integral brackets at the pilaster tops support an "I" beam crane track, upon which are pulleys and a catwalk. A ladder with a protective cage climbs to the catwalk, and to a hatch at the center of the ceiling's southern end. Rail tracks run down the center of the floor. At the north wall, a high rolling metal door provides equipment access to the exterior. A smaller rolling metal door at the west wall accesses Assembly Bay No. 2. The south wall features two sets of double door openings (doors removed); one opening is for the electrical shop and the other for the machine shop. Heating, ventilating, and air conditioning (HVAC) equipment is prominent in the space. Attached piping and conduit runs along the south and west walls. The east wall features wall vents and six large rectangular sheet metal ducts mounted on its lower half. Surface-mounted strip fluorescent lights run north-south at the ceiling.

Assembly Bay No. 2 (Room 136) is a later addition and higher and longer than Assembly Bay No. 1 (Photograph 14). It is about 100 ft (30 m) long, 60 ft (18 m) wide, and 60 ft in height. A variety of materials encase the space: the floor and a portion of the east wall is concrete; the lower portion of the south wall is CMU construction; and the remaining walls and ceiling are corrugated metal. The shallow gable roof is supported by metal trusses resting on deep steel columns along the east and west walls. Rolling metal doors provide access to the exterior on both the north and west elevations, and to Assembly Bay No. 1 on the east elevation. Like Assembly Bay No. 1, railroad tracks are in the floor, near the east wall, and enter the bay from the north door. Cage-enclosed ladders access catwalks located half-way up both the east and west walls. The ladder at the west catwalk is missing, but the cage survives. Lighting consists of two sizes of conical silver metallic pendants.

The Machine Shop (Room 102) is a roughly square room featuring a VAT floor, reinforced concrete walls, and a concrete waffle slab ceiling (Photograph 15). Thru-holes at the top of the east wall appear to have accommodated duct penetrations, although the ducts are no longer extant. Double doors access Assembly Bay No. 1 at the north wall, and a single door accesses the electrical room at the east wall. Jets, which allow even temperature and gas flow through the reactor core during tests, were placed on the reactor rods in this room.

The Electrical Maintenance and Instrumentation Lab (Room 103) is a rectangular room subdivided by a steel stud and gypsum board partition. Other walls are reinforced concrete, and the floor is VAT. The structural concrete waffle slab now functions as a finish ceiling, although a distinct paint line approximately 18 inches below the slab references a suspended acoustical ceiling. As in the machine shop, through holes at the top of the east wall appear to have accommodated duct penetrations, although the ducts are not longer extant. Double doors access Assembly Bay No. 1, at the north wall. Single doors also penetrate the west wall and the gypsum board partition within the room. Tasks carried out include field modifications to reactors and test cars, fabrication of a number of disassembly tools, and to fabricate cable stubs that would extend from the pressure vessel through the test car and then out to the main plug from the test car.

The Reactor Control Lab (Room 137) is a rectangular room featuring CMU walls, except for the reinforced concrete east wall (Photograph 16). Floors are VAT, and the ceiling is concrete waffle slab. A vent penetrates the top of south wall, at the east corner. An opening in the exterior wall may have held a thru-wall air conditioning unit. Doors include a rolling metal door accessing Assembly Bay No. 2 that is missing, but jambs and scars survive, and a single leaf door with a wire glass upper panel at the west wall. This room was used for control rod actuator checkout and calibration during the final stage of assembly.

The Core Storage and Assembly Room (Room 138) is an L-shaped, windowless room featuring reinforced concrete walls, VAT floors, and a concrete waffle slab ceiling. A duct intersection survives at the southwest corner of the room near the ceiling, but the ducts which once apparently ran along the south and west walls are now missing. An approximately 6 inch diameter cast iron pipe runs along the east wall. The room was used for the storage of fuel elements and classified core parts.

Second floor engineering offices, above the Reactor Control Lab and the Core Storage and Assembly Room, form a small suite, consisting of a main room ringed by several smaller rooms (Photograph 17). All have abated VAT floors and removed, suspended 2 x 4 ft acoustical tile ceilings. Exterior walls are CMU, while interior partitions are partial height frame construction. Stairs from Assembly Bay No. 2 are at the northeast corner of the main room, while a door to the roof is at the south wall. Recessed strip fluorescent fixtures light the floor.

The Service Entry (Room 159) is a long rectangular space with concrete floors and walls and a corrugated metal ceiling supported on light-gage metal trusses. A rolling metal door on the south wall accesses the exterior of the building, and one at the north wall accesses Assembly Bay No. 2. A checkered metal floor hatch penetrates the floor along the east wall.

The Equipment Room (Room 141) is a long, narrow space accessed only from the exterior (Photograph 18). It features a concrete floor, CMU and reinforced concrete walls, and a flat ceiling on steel supports. The room is crammed with HVAC equipment. Special features include a louvered door on the south wall, under an exterior staircase; and through-wall ventilation louvers at several locations along the south wall. White enameled metal industrial pendant fixtures light the space.

The Boiler Room (Room 105) is a nearly square, exterior-accessed room with concrete floor and walls and a concrete waffle slab ceiling (Photograph 19). Raised concrete pads on the floor hold equipment. In addition, ductwork and electrical equipment are mounted on the walls and ceiling. This room housed the heating unit for the building.

The Air Conditioning and Refrigerator Room (Room 104) is a square, exterior-accessed room featuring concrete floor and walls, and a structural concrete waffle slab ceiling with surface mounted fluorescent lights. A rolling metal door on the west wall accesses the exterior. A raised concrete pad holds a large piece of equipment. This room housed the building's main air conditioning equipment.

The eastern portion of Building 3110 contains the large, high disassembly bay on the north side of the building, with the smaller hot cell or Post-mortem Cell Complex at the south side (see Figures 9-12). This portion of the building consists of two full stories over a partial basement, a non-contiguous third floor consisting of two small rooms, and a fourth floor with only one small room. It is accessed from the interior by a ramp from the administrative corridor (Photograph 20) and from the exterior by several personnel doors and a large shielding door on the Disassembly Bay.

The Disassembly Bay was used to disassemble the nuclear reactor after testing. The reactor was brought into the bay on a railroad test car through the main shielding door on the north side of the building. The bay door was then closed and the reactor was removed from the test car and disassembled by remotely operated manipulators. Disassembly operations were viewed through thick, yellowish-colored windows. Remote handling equipment included two side wall manipulators, an overhead manipulator, a turn-table for easy positioning of the reactor after its removal from the test car, and an overhead crane with 5 and 25-ton lifting capabilities. A remotely-controlled TV camera boom was available for viewing any point in the bays.

The large rectangular Disassembly Bay, Room 123, is 59.5 ft (18 m) high, 40 ft (12 m) wide, and includes a lower level 60 ft (18 m) long to the north (Photographs 21-22) and a raised upper level 31 ft (9 m) long to the south (Photographs 23-24). Floors, walls, and ceiling are reinforced concrete. The interior walls are 6 ft (1.8 m) thick, while the exterior north wall is 12 ft (3.7 m) thick. A 400 ton (363 m ton) shielding door, 29 ft (8.8 m) high, 26 ft (7.9 m) wide, and 6 ft thick, dominates the north wall. A second shielding door, when emplaced, separates the lower and upper levels of the bay. It weighs about 750 tons (681 m tons) and is 5 ft (1.5 m) thick. Incandescent lights with metal shades, and ceiling mounted ducts, hang from the ceiling. Railroad tracks lead into the middle of the lower room from the shielding door. Personnel access this space through a sliding airlock door on the west wall. The south wall, beneath the balcony separating the upper level from the lower level, features three viewing windows (glass removed) - two low and one high. Crane tracks, mounted along the north and south walls near the ceiling, support a crane with hook and pulley as well as an overhead manipulator. An overhead manipulator, currently situated in the northwest corner, also mounts to the crane tracks. A catwalk runs across the short distance of the room near the ceiling, going in an east-west direction. A ladder climbs to the balcony.

The upper Disassembly Bay continues southward and above the south wall of the lower Disassembly Bay. It is also above the first floor viewing gallery and the Transfer and Decontamination rooms of the Post-Mortem Cell Complex. The upper bay is accessed by ladder from the lower bay, and through a sliding personnel access/shielding door on the west wall from a second floor passageway, Room 220. The south wall features two large and one small viewing windows, with one remaining pair of manipulator arms. One viewing window, from the Master Control Room, occurs at the southeast corner. A ladder at the west wall ascends to overhead crane tracks. Two hatches are in the floor of the upper bay, one to a decontamination room and the other to the post-mortem cells.

The Post-mortem Cell Complex consists of a series of small, connected hot cell rooms (Photographs 25-29). Most of this space was not part of the original construction and was added later. The area consists of the South Hot Cell Corridor (Room 149), accessing five small hot cells (Rooms 144-148); the Transfer Room (Room 126 at the north end of Room 149), containing a turn table and a ceiling hatch where parts of the reactor were lowered from the upper Disassembly Bay; the Cask Storage Room (Room 127); and the East Hot Cell Corridor (Room 132) that accesses two small hot cells (Rooms 133 and 134) which were original to the structure. The other hot cells, Rooms 144-148, were added later. Ancillary spaces, providing access, dressing, and viewing and work stations, surround the complex. Room 149 corridor features rail tracks in the center of the floor leading to the outside of the building through a rolling metal door at the south end of the corridor. At the north end of the corridor (see Photograph 27), the tracks take a 90-degree turn to the east on a swivel plate and enter Rooms 127 and 132, the East Hot Cell Corridor. The small hot cells, Rooms 133 and 134, which flank this corridor, are accessed through partial- or full-height openings and each has a viewing window to the surrounding corridor. Equipped with manipulator arms and other disassembly equipment, activities conducted in the small hot cells included sectioning fuel elements, milling, close visual inspection, photography, radiography, sonic velocity testing, and probolog testing.

The main part of the partial basement consists primarily of a U-shaped corridor wrapping around the foundation wall of the Disassembly Bay (Photograph 30). Stairs from the first floor are located toward the southwest and southeast corners of the corridor. Typical finishes in the basement include concrete walls, abated VAT floors over concrete, and 1 x 1 ft glue-up acoustical tile ceilings. Lighting includes both strip fluorescent, incandescent metal industrial lights, and metal enameled pendants. Electrical panels and conduit mount to walls adjoining the Disassembly Bay. Four small rooms are accessed from the corridor and include two storage rooms and two small janitorial closets. The storage rooms are adjacent rectangular rooms, each having a concrete ceiling, abated VAT floors, and surface-mounted florescent lights. The exterior walls are CMU and the interior walls are concrete. In addition, two basement hot cells, the East Hot Cell (Room 6), and the South Hot Cell (Room 7) are accessed only from exterior stairs, and were inaccessible at the time of this survey because of unknown levels of radiological contamination.

The first floor is primarily two levels of corridor/viewing galleries around the Disassembly Bay and the Post-mortem Cell Complex. The upper level viewing gallery, Rooms 124 and 124A, is a U-shaped corridor around the Disassembly Bay featuring an abated VAT floor with a 2 x 4 ft suspended acoustical tile ceiling (Photographs 31-32). Activities in the Disassembly Bay, Room 123, were viewed from this gallery through six foot thick windows on the north, east, and west sides. These windows are boarded up now. A view window on the south wall faces the smaller hot cell complex. Along the ceiling of the upper gallery are integral florescent strip lights. In the west corridor is a 4 x 4 ft metal-lined recessed ceiling hatch. Controls line the north wall. Tray cable runs hang above the observation windows. The southwest corner of the upper viewing gallery has been partitioned off to create an anteroom between the entrance ramp and the remainder of Room 124. Rooms 129 and 130 are toward the southeast corner of the gallery and adjoin perpendicularly to the corridor. Room 130 is reached through Room 129. These adjoining rectangular rooms have concrete floors, walls, and ceiling. Industrial metal pendants light the spaces. Room 129 was originally a janitor's closet and has a janitor sink mounted to the north wall. Room 130 was used for storage of material and equipment, and later, both were used as locker rooms.

Spaces surrounding the Post-mortem Cell Complex include two U-shaped galleries (Room 135 and Rooms 143 and 150-153); a South Hot Cell Hallway; and an access/vestibule suite that includes an Anti-C Locker Room (Room 25) and a Hot Change Room (Room 125A). Access to this lower level from the upper level gallery, Room 124, is either by stairs at the southeast corner down to Room 135 or by stairs at the southwest corner from the anteroom mentioned above down to Room 128. Several exterior entranceways are on the east and south sides. Room 135 is U-shaped around an east extension of the Post-mortem Cell Complex, and includes a corrugated metal ceiling, abated VAT floors, and surface-mounted florescent lights (Photograph 33). Viewing windows, currently boarded over, face into the original Post-mortem Cell Rooms 133 and 134. A partial-height suite of two rooms (Rooms 131 and 142), constructed of wood framing, is located in the southeast corner and were used as an x-ray dark room. Double doors with glazed upper panels lead to the outside from the northeast corner.

Rooms 143 and 150-153 form a second operating gallery around the southern part of the hot cell complex (Photographs 34-35), servicing Post-mortem Cell Rooms 144-148 through viewing windows at various work stations in the gallery. Rooms 143 and 150 form the east corridor of the gallery. It is through Room 151 at the south end that entrance to the interior of the post-mortem cells is made. The gallery has abated VAT flooring, a corrugated steel ceiling on a light gauge metal truss system, and surface-mounted florescent lights. The exterior walls are CMU, while reinforced concrete shielding walls separate the rooms from the adjacent hot cells. All viewing windows, which provided visual access to the hot cells, are boarded up. The west wall of Room 152, the west corridor of the gallery, features a small ceiling-mounted crane.

Vestibule Room 128 has reinforced concrete walls, a concrete ceiling, and abated VAT floors. A large roll-up door, currently infilled with plywood, accesses the space from the exterior. This room served as a machine shop, with benches and other equipment, such as lathes and drill presses, for the hot section. From this room, personnel access doors lead to Room 124, an upper level first floor corridor, via a short flight of stairs, and to Rooms 125, 125A, and Room 152. Room 125 was originally the Decontamination Room, with a ceiling hatch from the upper Disassembly Bay, but has since been divided and used as a decontamination and repair Room, while Room 125A was a hot change room. They have showers, restrooms, and lockers, and low acoustical tile ceilings. Room 152 is the western section of the southern operating gallery around the post-mortem cells.

The second floor consists of a viewing gallery and corridor, designated Room 205, that wraps around the south and east sides of the Disassembly Bay (Photograph 36). It is reached from a staircase at the north end of the east corridor. The main features of this L-shaped corridor are viewing windows and stations into both the upper and lower levels of the hot bay, the Master Control Room (Photograph 37), and two staircases leading to the third floor. One pair of manipulator arms in the southern corridor is still attached to the wall of the Disassembly Bay (Photographs 38-39). Floors are abated VAT, while the ceiling is 2 x 4 ft acoustical tile. A checkered metal floor hatch penetrates the north end of the east corridor. A spiral metal staircase leading to a third floor room is at the center of the east wall and a second metal staircase along the south wall of the south corridor leads to a different third floor room. The west corner of the south corridor was once used for a training and conference room, and just around the corner from this room to the north is Room 218, a small camera station into the upper level of the Disassembly Bay. A small toilet room and janitor closet, Room 206, is across from the Master Control Room.

The Master Control Room, Room 203 (see Photograph 37), is a small, triangular space accessed from the second floor viewing gallery down a short flight of stairs. All the surfaces of this room are concrete, although VAT once covered the floor and 1 x 1 ft glue-up acoustical tile covers the ceiling. Controls cover the west wall. Two observation windows face the Disassembly Bay, one for the upper level and one for the lower. A television camera mounted on manipulators boom attached to the east wall made it easier to view objects which were difficult to see from the viewing windows. Coordination of all remote handling activities and equipment within the hot bay, as well as all entries, was conducted from this room.

The third floor consists of two non-contiguous spaces, accessed by separate staircases. Room 302 is an office, accessed from the second floor by a spiral staircase from the east corridor (Photograph 40). The space has CMU walls, abated VAT flooring, and a corrugated metal ceiling supported by a light gauge steel truss system. Metal awning windows at the east wall provide natural light. The 1 x 1 ft acoustical tile ceiling was suspended about eight inches below the metal ceiling, but most is now gone. Strip florescent lighting mounts flush to the ceiling. A checkered metal floor hatch, above that described for Room 205, penetrates the floor, with a second ceiling hatch directly above that goes to Room 401.

Room 303, a camera gallery (Photograph 41), is accessed by a standard metal staircase in the south corridor of the second floor. This rectangular space features one concrete and three corrugated metal walls. The concrete wall is part of the disassembly bay. A door leading to the roof is in the east corrugated metal wall. The floor is abated VAT, and the ceiling is corrugated metal. Pieces of equipment mount to the concrete wall.

The one room fourth floor, Room 401, is a viewing gallery into the Disassembly Bay and accessed from Room 302 by a spiral staircase (Photograph 42). Room 401 is located directly above Room 302 and is similar to the lower room in size and other aspects, but has no awning windows. As mentioned above, there is a floor hatch to the room below.

## III. HISTORICAL INFORMATION

The concept of nuclear-propelled rockets was initially discussed in 1944 by personnel at both LASL and the University of Chicago Metallurgical Laboratory (Bussard 1962:169; Bussard and DeLauer 1965:1). Following these discussions, the first serious study dealing with the concept of nuclear-powered rockets, aircraft, and ramjets, according to Bussard (Bussard 1962:169; Bussard and DeLauer (1965:2), was produced in 1946 as a secret document by personnel at the Applied Physics Laboratory, John Hopkins University. This document summarized the contemporary information about nuclear propulsion and the principles and problems for developing such systems. What was made evident in the document was that little or nothing was known about specific properties of materials in order to build the systems. A second secret document was prepared in 1947 by the Aerophysics Laboratory, North American Aviation Corporation, focusing on nuclear ramjets and rockets of different sizes for military purposes (Bussard 1962:170; Bussard and DeLauer 1965:2).

In 1946, the U.S. Air Force established the Nuclear Energy for Propulsion of Aircraft (NEPA) project at the Oak Ridge National Laboratory, Tennessee for exploring the possibility of low-altitude nuclear aircraft (Bussard and DeLauer 1965:2; Larson 1950:2). Work on this project continued intermittently until 1949 (Bussard 1962:170). The Lexington Project, an ad hoc study group convening in 1948 at the Massachussets Institute of Technology at the behest of the AEC, determined the least difficult system to develop was the low-altitude nuclear aircraft, followed by the nuclear ramjet for powering missiles, with the nuclear rocket being the most difficult. The NEPA project evolved into a new and expanded Aircraft Nuclear Propulsion (ANP) program in 1951 when the U.S. Air Force joined with the AEC to develop the systems, focusing primarily on manned military aircraft (AEC 1956). In 1955 the U.S. Navy also became interested and requested a feasibility study for a nuclear-powered seaplane (AEC 1956). The ANP program ended in 1961, however, with few results (Bussard and DeLauer 1965:4). In contrast to the earlier beliefs, it was found that a nuclear-propelled low-altitude aircraft was the most difficult of the three systems to develop, due mostly to size constraints and safety considerations. Furthermore, it was determined little advantage was to be gained in developing ballistic missiles powered by nuclear engines when compared to already developed chemically-propelled missiles and effort and money could be spent more efficiently elsewhere (General Advisory Committee 1960:28; Baker 1996:62).

In the 1950s, an article by Bussard (1953), who was working at the Oak Ridge National Laboratory at the time, on the potentialities of a wide range of missions for nuclear rockets, sufficiently influenced the U.S. Air Force to direct, through the AEC, the LASL and the University of California Radiation Laboratory (UCRL), Livermore, California (now known as the Lawrence Livermore National Laboratory) to study the feasibility of linking nuclear power with rockets (AEC 1962:71; Baker 1996:48-49; Bussard 1962:170; Bussard and DeLauer 1965:3; House 1963). The great appeal of nuclear propulsion, as opposed to chemical propulsion, was its smaller size and greater velocity to enable bigger payloads. Consequently, it was considered more efficient and preferable than chemical systems, particularly in the long and complex journeys for exploring the solar system (see Angelo and Buden 1985:ix; Schreiber 1961:25, 29). In 1955, the Condor committee of the U.S. Air Force Scientific Advisory Board recommended that work was to begin on a nuclear-propelled rocket (Baker 1996:55; House 1963). In 1957, a Rover reactor approach using uranium-loaded graphite fuel was selected as the method to be developed based on the studies by LASL and UCRL (AEC 1962:71). Construction and testing of reactors for rockets was assigned to LASL within the Rover project, while UCRL was given a similar task for missiles and ramjets, thereafter referred to as the Pluto program (AEC 1958a, 1958b; Schreiber 1958:70).

The NTS, with a record of nuclear weapons testing, including atmospheric or above ground tests, was chosen as the place to conduct the nuclear reactor tests because of the possibility of an excursion within the reactor, and also, the tests released a radioactive exhaust plume into the atmosphere that was acceptable for the NTS at the time (AEC 1958a; see Bernhardt et al. 1974; House 1963; see Friesen 1995). Initial development of the NRDS in 1956 was a joint AEC and U.S. Air Force effort that eventually evolved into an AEC and NASA project (AEC 1957:10, 1958a, 1961:71, 1964:109; Beck et al. 1996:26; Baker 1996:57; House 1963; Miller 1984:1). In 1961, the NRDS area, about 318,000 acres, were officially withdrawn to the AEC from the Nellis Air Force Range under Public Land Order 2568 (Space Nuclear Propulsion Office 1969:75). The mission of the AEC was to develop nuclear reactors and reactor technology, while NASA, who had taken over the role from the U.S. Air Force, had the responsibility to develop nuclear engines and engine technology and for the integration of the reactors into engines (AEC 1963:168). Administration of the program was by a newly created Space Nuclear Propulsion Office located in Georgetown, Maryland, headquarters of the AEC, with operating extensions in Albuquerque, Cleveland, and Las Vegas.

The primary mission of the NRDS at the NTS was to support the Rover project in developing nuclear rocket reactors and engines for the space program (AEC 1961:69; House 1963; Miller 1984:1). Initially, three stages were outlined for the program. The first stage was to develop test reactors in order to investigate and solve various problems in achieving a high-power density, to develop reactor materials capable of withstanding high temperatures, and to generate new concepts for converting nuclear energy into useful propulsion forms (AEC 1960:77). The second stage was to develop and test a nuclear engine for actual flight and the third stage, performed by NASA, was to incorporate the engine into a Saturn V launch vehicle for flight testing (AEC 1964:109; Schreiber 1961:33).

The first nuclear rocket test reactor at the NRDS, designated Kiwi-A, was conducted in 1959 (AEC 1961:69; Bussard and DeLauer 1965:3; Schreiber 1961:29). More test series followed, including Phoebus, NRX, Peewee, XE, and Nuclear Furnace (Angelo and Buden 1985:179-183; DOE/NV 1985:2-2, Table 6.2.1; Friesen 1995). Following the initial outline of the Rover project, the objective of the Kiwi test series was to develop the reactor technology and design (Schreiber 1958:70). The Kiwi reactor, appropriately named after a flightless New Zealand bird, would become the basic design for the NERVA (Nuclear Engine for Rocket Vehicle Application) engine planned to be flight-tested in the RIFT (Reactor in Flight Test) vehicle (AEC 1963:168, 1965:111). The RIFT vehicle would then be developed for an upper stage on an advanced Saturn rocket, capable of putting large payloads on the moon for lunar-based missions. The module could also be used for manned missions to Mars or Venus (AEC 1967:181).

In late 1963, the Rover project was revised, emphasizing ground-based research and engineering. That is, the Kiwi project was unchanged, worked continued on the NERVA engine technology, but the planned RIFT stage was cancelled (AEC 1964:110). Early in 1972, the NERVA project was cancelled (AEC 1973:25). Eventually, further budget restrictions in 1973 led to a termination of all space-oriented nuclear propulsion development efforts and the entire NRDS program was phased out at the end of the fiscal year. Despite this rather abrupt ending, the significant technological advances made during the Rover project proved the feasibility of nuclear-propelled vehicles and constitute the primary building blocks for future space explorations in the twenty-first century (e.g., Porta 1995). Overall, the program can be considered a successful pioneering achievement in the space program of the United States.

## IV. SOURCES

Angelo, Joseph A., Jr. and David Buden
1985 *Space Nuclear Power*. Orbit Book Company, Inc., Malabar, Florida.

Atomic Energy Commission (AEC)

1956 *Annual Report of the Atomic Energy Commission to the National Security Council.* Manuscript on file, Accession No. 73444, Coordination and Information Center, Las Vegas, Nevada.

1957 *Twenty-first Semiannual Report of the Atomic Energy Commission.* United States Government Printing Office, Washington D.C.

1958a *Background Information on Los Alamos and Livermore Nuclear Propulsion Projects, and the Static Test Area being Developed at the Commission's Nevada Test Site.* Manuscript on file, Accession No. 78616, Coordination and Information Center, Las Vegas, Nevada.

1958b *Background Information on Los Alamos and Livermore Nuclear Propulsion Projects and the Static Test Area being Developed at the Nevada Test Site.* Manuscript on file, Accession No. 74193, Coordination and Information Center, Las Vegas, Nevada.

1960 *Annual Report to Congress of the Atomic Energy Commission for 1959.* United States Government Printing Office, Washington D.C.

1961 *Annual Report to Congress of the Atomic Energy Commission for 1960.* United States Government Printing Office, Washington D.C.

1962 *Annual Report to Congress of the Atomic Energy Commission for 1961.* United States Government Printing Office, Washington D.C.

1963 *Annual Report to Congress of the Atomic Energy Commission for 1962.* United States Government Printing Office, Washington D.C.

1964 *Annual Report to Congress of the Atomic Energy Commission for 1963.* United States Government Printing Office, Washington D.C.

1965 *Annual Report to Congress of the Atomic Energy Commission for 1964.* United States Government Printing Office, Washington D.C.

1967 *Annual Report to Congress of the Atomic Energy Commission for 1966.* United States Government Printing Office, Washington D.C.

1973 *Annual Report to Congress: Operating and Developmental Functions.* United States Government Printing Office, Washington D.C.

1974 *Annual Report to Congress: Volume 1 - Operating and Developmental Functions.* United States Government Printing Office, Washington D.C.

Baker, David
1996 *Spaceflight and Rocketry: A Chronology.* Facts On File, Inc., New York.

Beck, Colleen M., Nancy G. Goldenberg, William G. Johnson, and Clayton Sellars
1996 *Nevada Test Site Historic Structures Survey.* Technical Report No. 87, Quaternary Sciences Center, Desert Research Institute, Las Vegas, Nevada.

Beck, Colleen M., Nancy G. Goldenberg, and Diane L. Winslow
1995 *A Historical Evaluation of Jr. Hot Cell for Characterization Activities Associated with Decontamination and Decommissioning, Area 25, Nevada Test Site, Nye County, Nevada.* Cultural Resources Reconnaissance Short Report No. 0332095-1, Desert Research Institute, Las Vegas, Nevada.

Bernhardt, D.E., R.B. Evans, R.F. Grossman, F.N. Buck, and M.W. Carter
1974 *NRDS Nuclear Rocket Effluent Program, 1959-1970.* Report No. NERC-LV-539-6, U.S. Environmental Protection Agency, Las Vegas, Nevada.

Bussard, Robert W.
1953 *Nuclear Energy for Rocket Propulsion.* Report No. ORNL CF-53-6-6, Oak Ridge National Laboratory, Tennessee.

1962 Nuclear Fission Rockets: Problems, Progress and Promise. In *Advances in Astronautical Propulsion*, edited by C. Casci, pp. 165-220. Pergamon Press, New York and Editrice Politecnica Tamburini, Milan.

Bussard, Robert W. and R.D. DeLauer
1965 *Fundamentals of Nuclear Flight.* McGraw-Hill Book Company, New York.

Carlson, Kathleen A.
1999 *Selection of End Points for Deactivation and Decommissioning (D&D) Facilities at the Nevada Test Site (NTS).* Manuscript on file, Department of Energy, Nevada Operations Office, Las Vegas.

Department of Energy, Nevada Operations Office (DOE/NV)
1985 *Nevada Test Site Facilities for SP-100 Ground Engineering Systems (GES) Tests.* U.S. Department of Energy, Nevada Operations Office, Las Vegas, Nevada.

Friesen, H.N.
1995 *Radiological Effluents Released from Nuclear Rocket and Ramjet Engine Tests at the Nevada Test Site, 1959 through 1969*. Raytheon Services Nevada, Las Vegas. Report No. DOE/NV-401, Department of Energy, Nevada Operations Office, Las Vegas.

General Advisory Committee
1960 *Minutes of the Seventy-First Meeting of the General Advisory Committee to the United States Atomic Energy Commission*. Manuscript on file, Accession No. 73743, Coordination and Information Center, Las Vegas, Nevada.

House, William C.
1963 *The Development of Nuclear Rocket Propulsion in the United States*. Paper presented to the British Interplanetary Society Advanced Propulsion Symposium, London, England.

Larson, C.E.
1950 *Brief History of the Aircraft Nuclear Propulsion Project at ORNL*. Manuscript on file, Accession No. 723853, Coordination and Information Center, Department of Energy, Nevada Operations Office, Las Vegas.

Miller, M.G.
1984 *Nevada Test Site Area 25 Radiological Survey and Cleanup Project 1974-1983*. Reynolds Electrical & Engineering Company, Inc., Las Vegas, Nevada.

Porta, Edward W.
1995 *NERVA-Derived Reactor Coolant Channel Model for Mars Mission Applications*. M.S. thesis, Department of Mechanical Engineering, University of Nevada, Las Vegas.

Schreiber, Raemer E.
1958 Los Alamos' Project Rover. *Nucleonics* 16(7):70-72.

1961 Nuclear Rockets (Project Rover). In *Advanced Propulsion Techniques*, edited by S.S. Penner, pp. 25-33. Pergamon Press, New York.

Space Nuclear Propulsion Office
1969 *NRDS Master Plan, 1969-1970*. Manuscript on file, Department of Energy, Nevada Operations Office, Las Vegas.

## V. PROJECT INFORMATION

This documentation has been prepared at the request of the Department of Energy, Nevada Operations Office in response to the management of cultural resources on the Nevada Test Site. Building 3110, the main structure of the R-MAD complex, is currently slated to be demolished under the DOE/NV Environmental Management Deactivation and Decommissioning Program. Project manager and co-principal investigator for the recordation of the R-MAD facility was Dr. Colleen M. Beck, cultural resources specialist, of the Desert Research Institute, Las Vegas, Nevada. Harold Drollinger, professional archaeologist, of the Desert Research Institute, Las Vegas, Nevada served as the other co-principal investigator. Nancy Goldenberg of Carey & Company, Inc. Architects, San Francisco, California was the historic architect for the project. The professional photographer was Richard Smith of Bechtel Nevada in Las Vegas, Nevada. This documentation is based on a previous investigation by the Desert Research Institute, reported in Cultural Resources Reconnaissance Short Report No. SR022900-1, *An Historical Evaluation of the R-MAD Building in Area 25 for Planned Activities Associated with the Environmental Management Decontamination and Decommissioning Program, Nevada Test Site, Nye County, Nevada*, 2000.

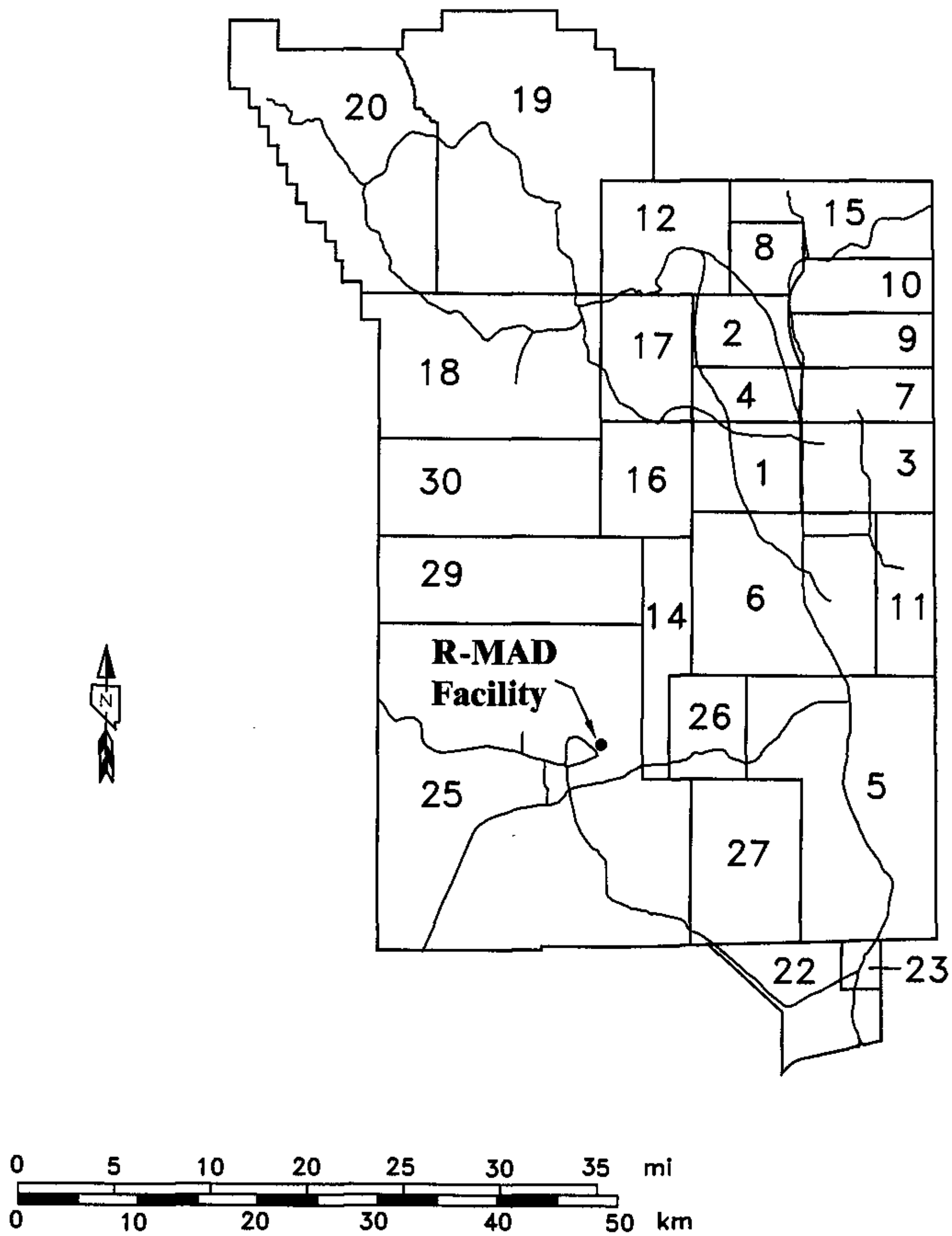


Figure 1. General location of the R-MAD Facility on the Nevada Test Site.

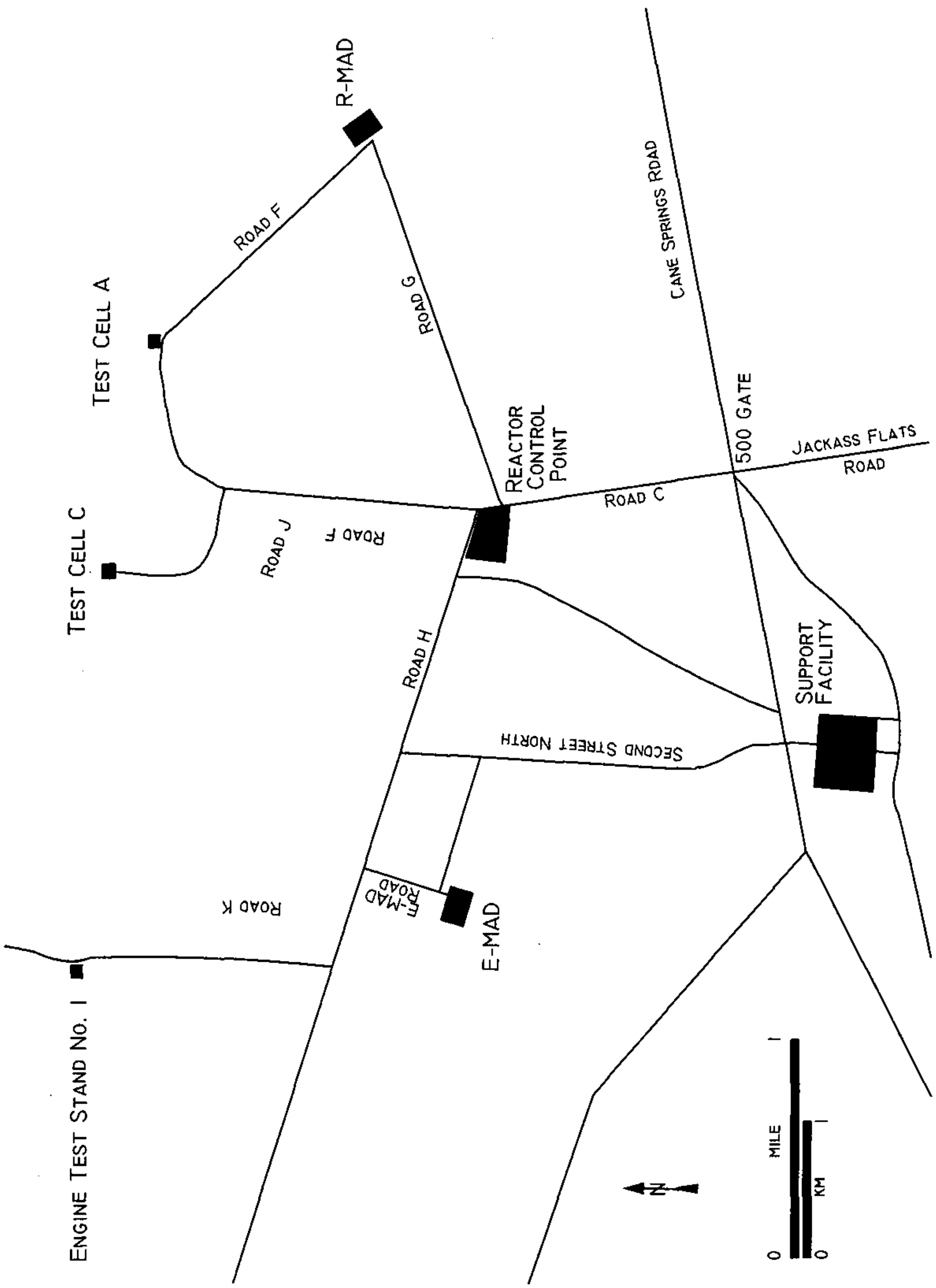


Figure 2. Major facilities of the Nuclear Rocket Development Station.

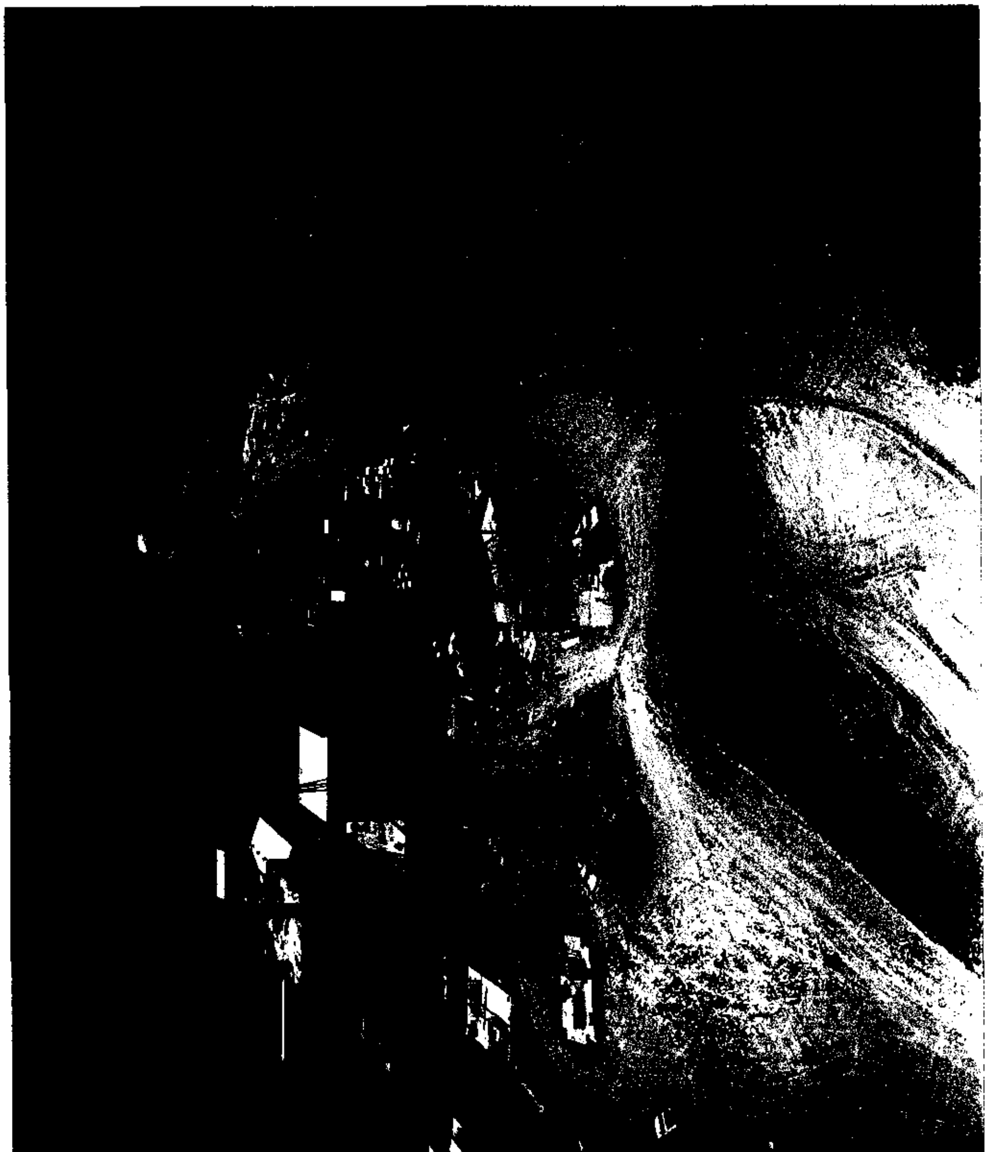

Figure 3. Aerial view south of the R-MAD Facility during construction phase of the MX Canister Program structures, with cold assembly area to the right and the hot disassembly area to the left, ca. late 1970s.

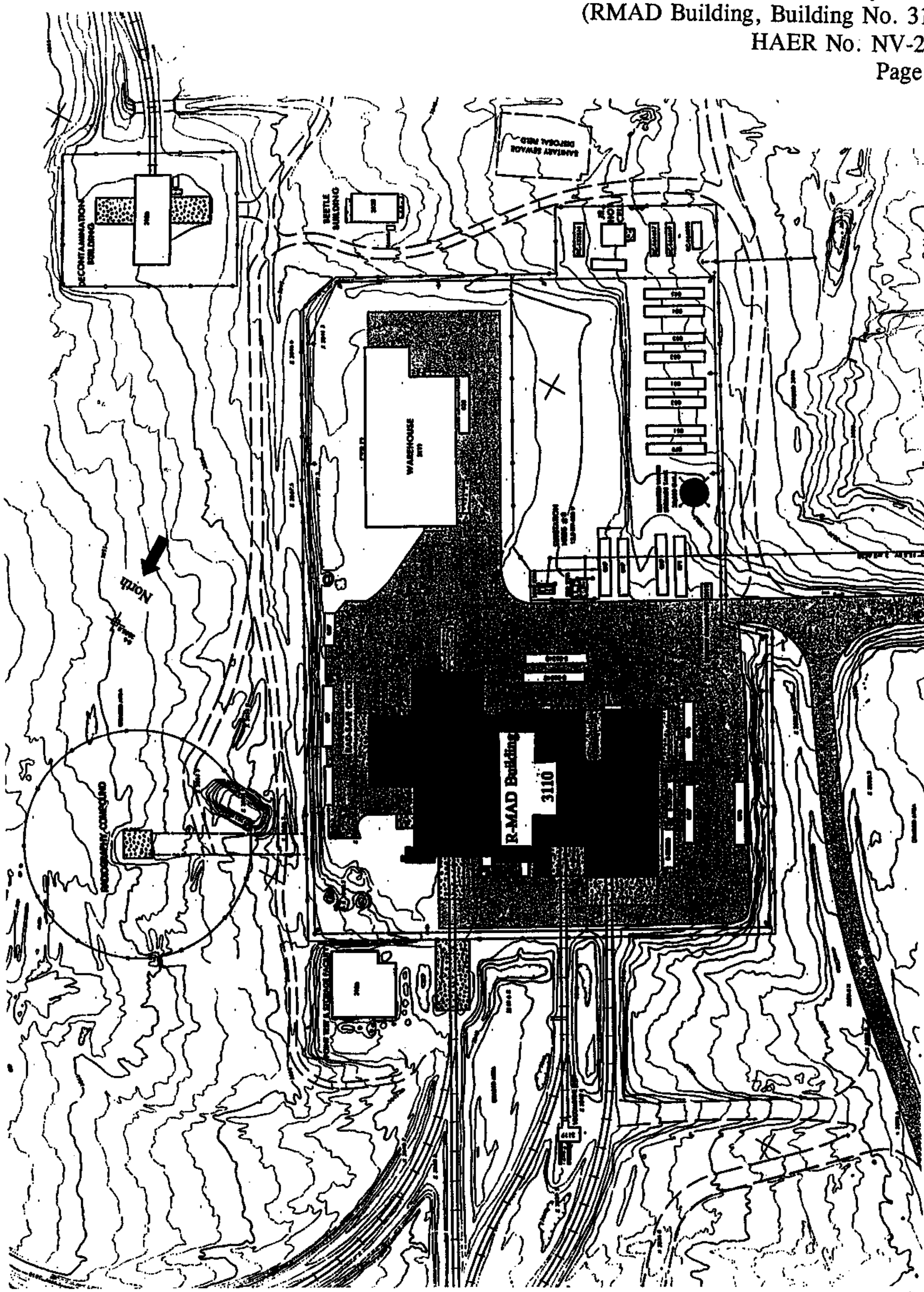


Figure 4. Plan map of R-MAD Facility, ca. 1965.

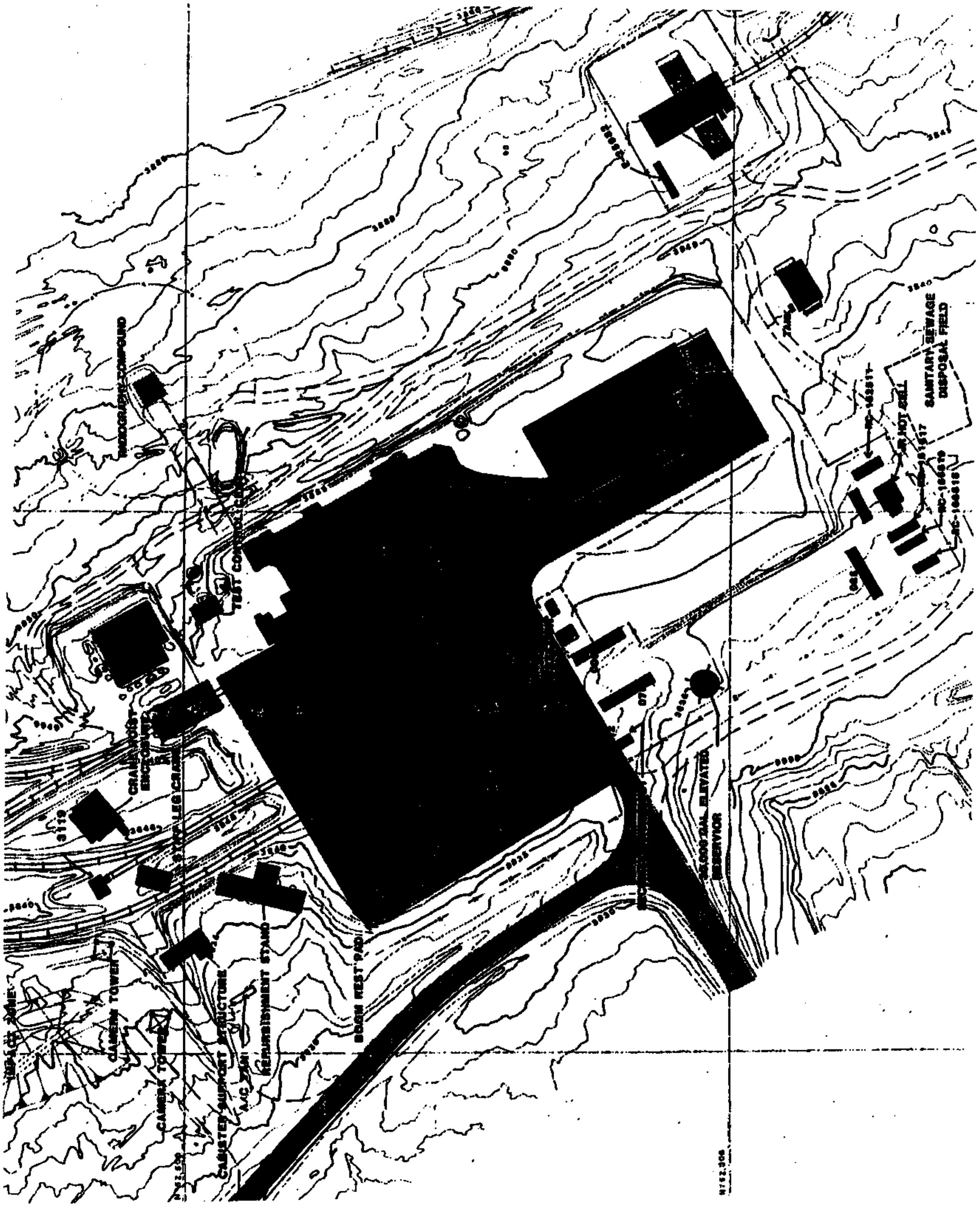

Figure 5. Plan map of the R-MAD Facility and MX Canister Program structures, ca. 1994.

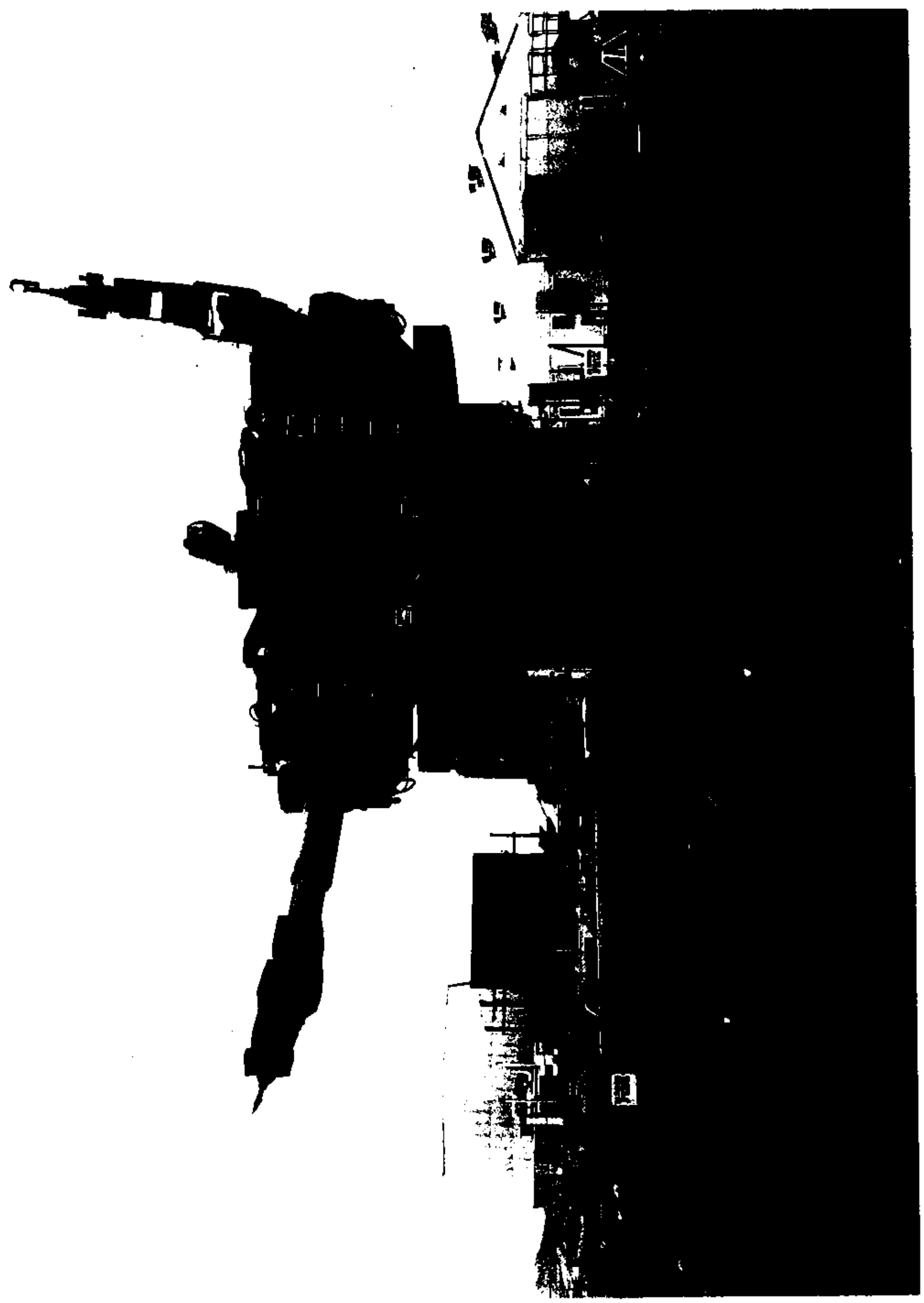

Figure 6. General Electric "Beetle," ca. 1964.

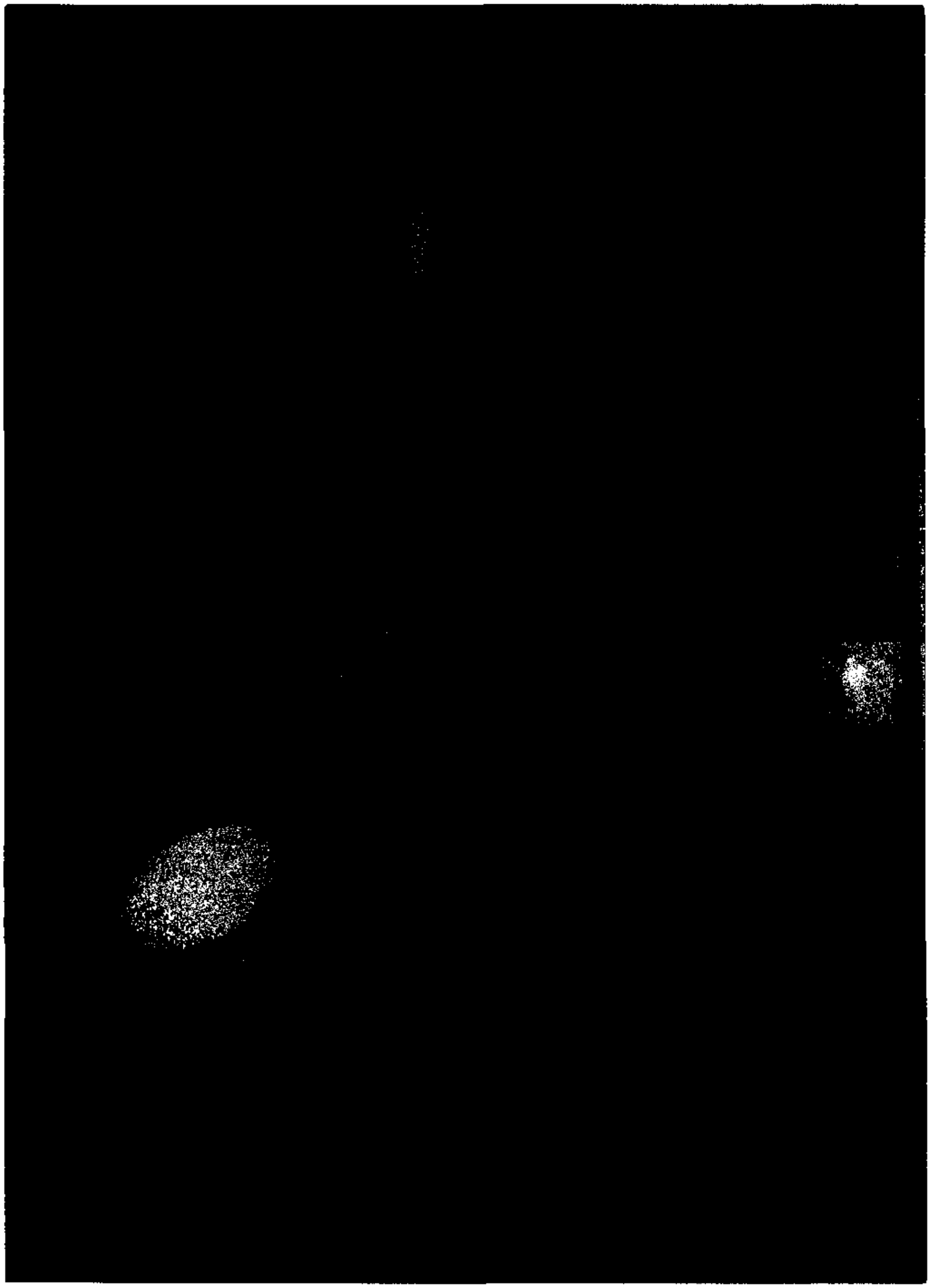

Figure 7. President John F. Kennedy at a gallery workstation within the R-MAD Facility, ca. 1961.

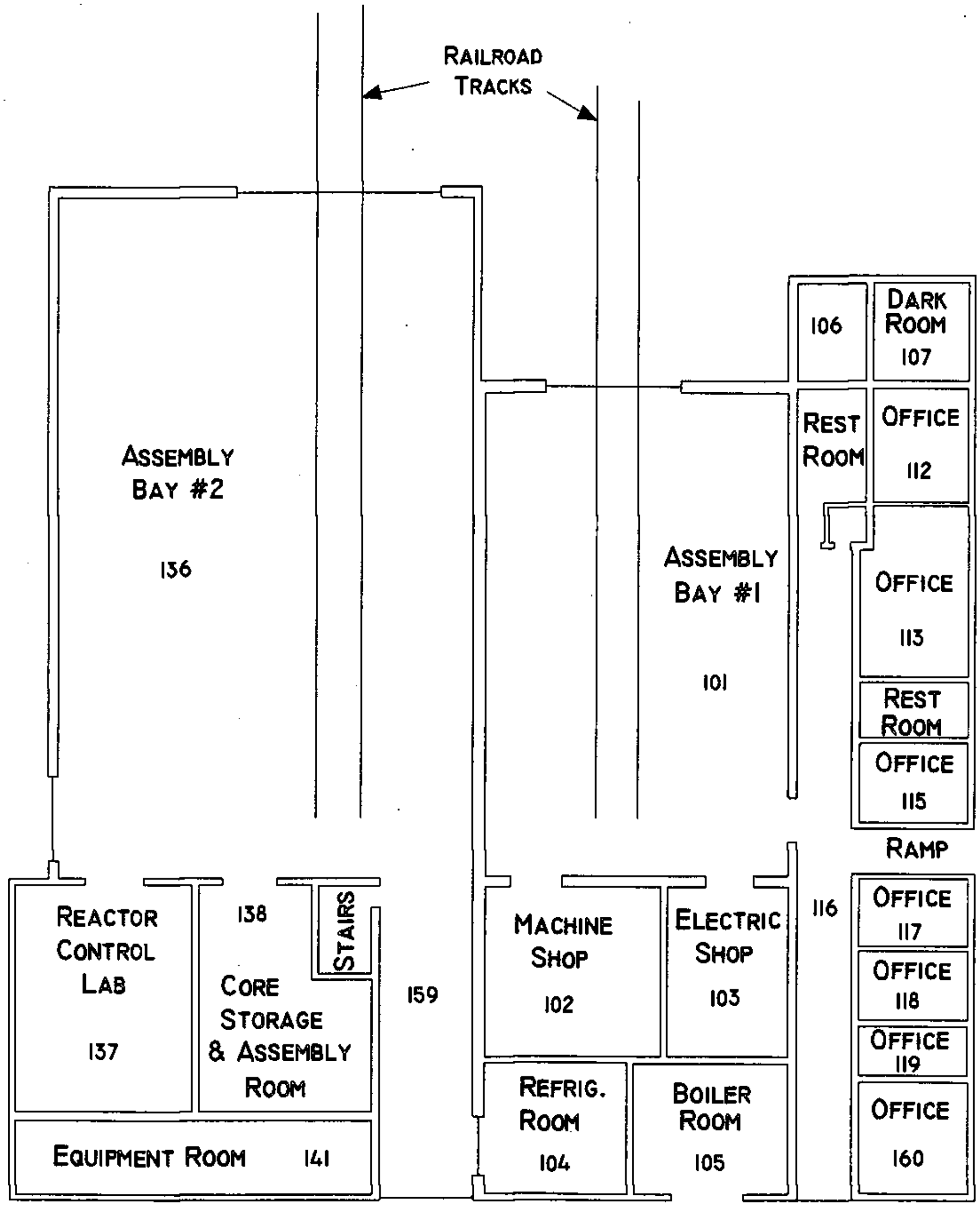


Figure 8. Floor 1 plan map of the administrative and cold assembly areas.

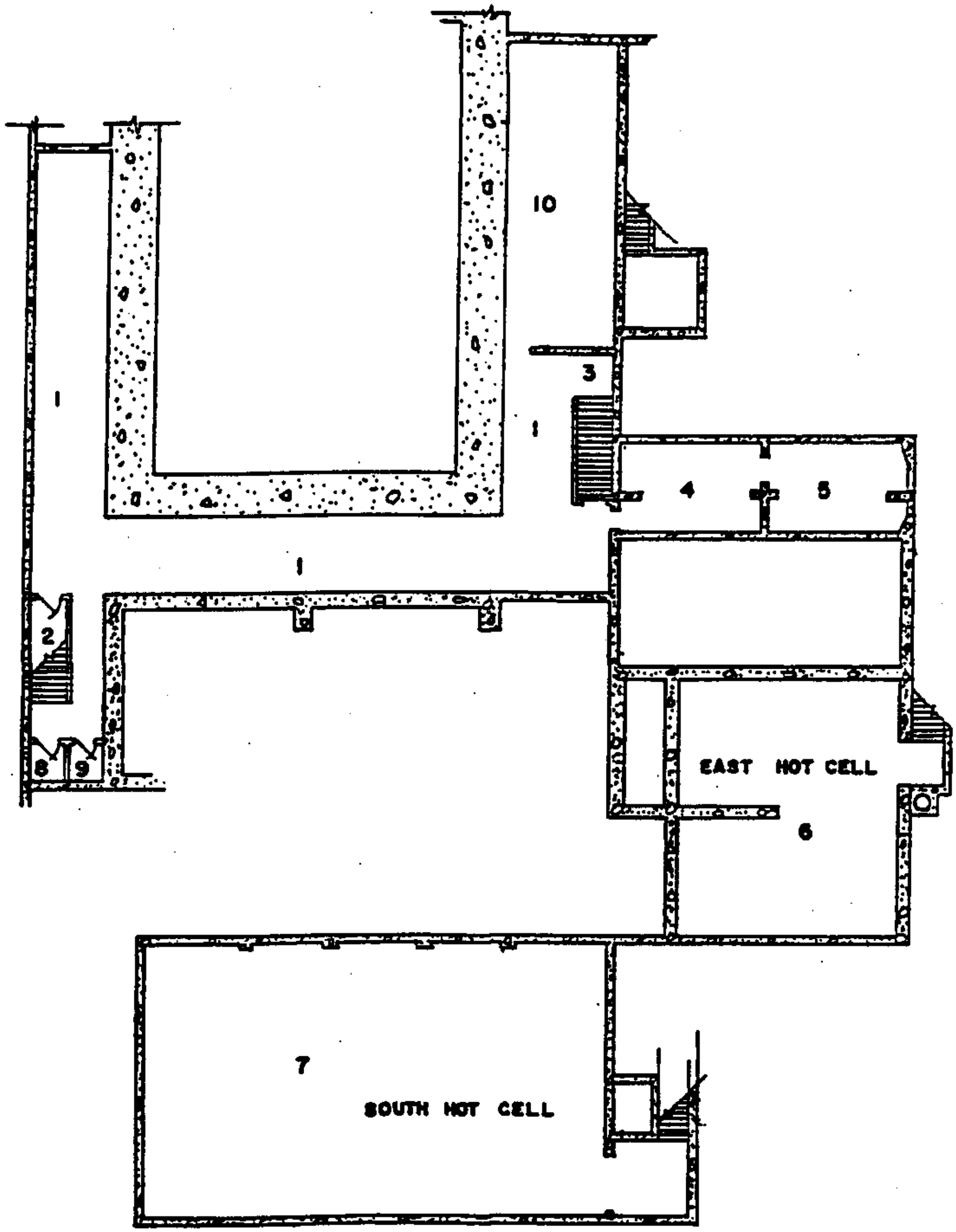


Figure 9. Basement plan map, hot disassembly area.

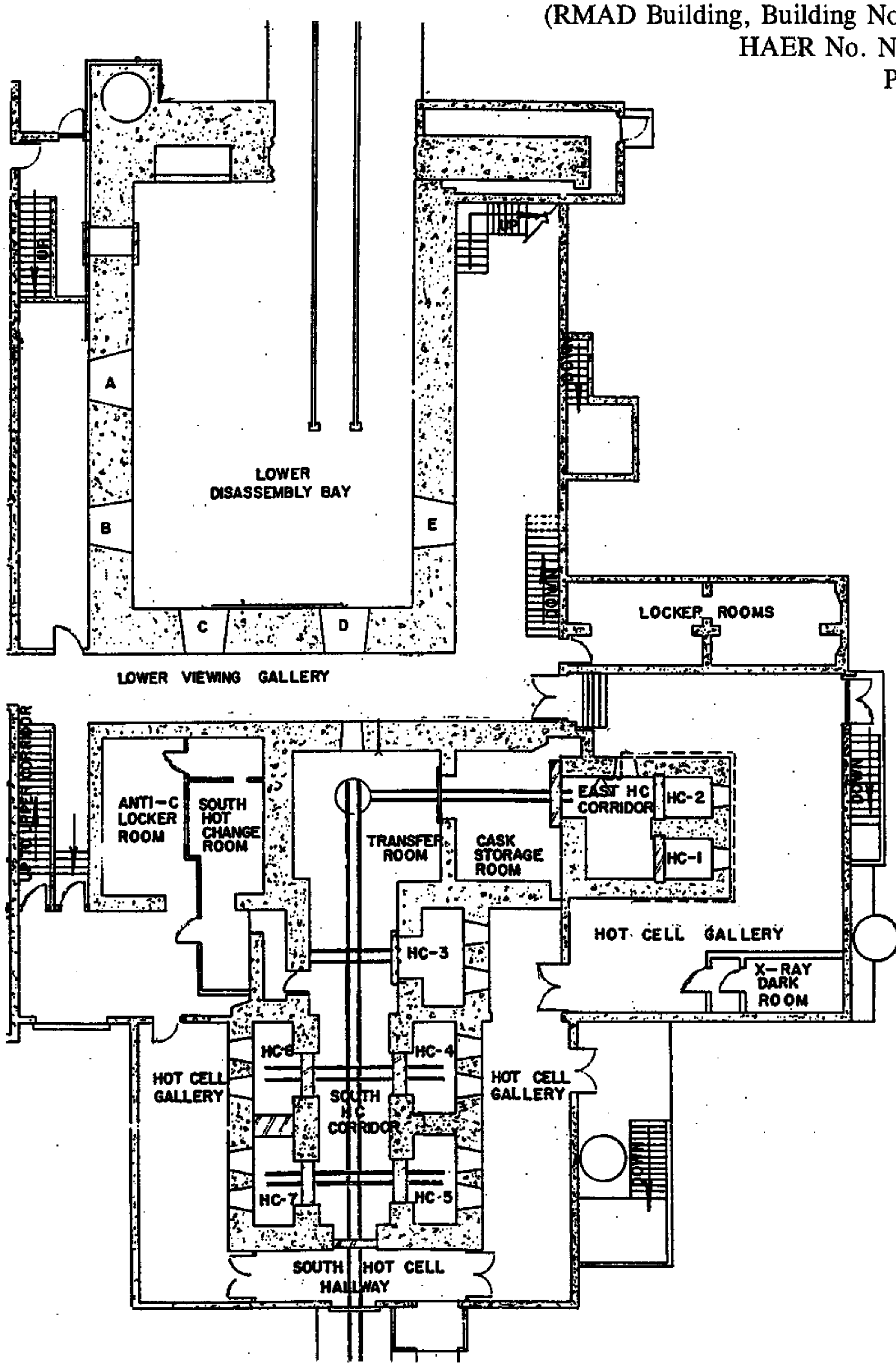


Figure 10. Floor 1 plan map of the hot disassembly area, including the post-mortem complex and galleries.

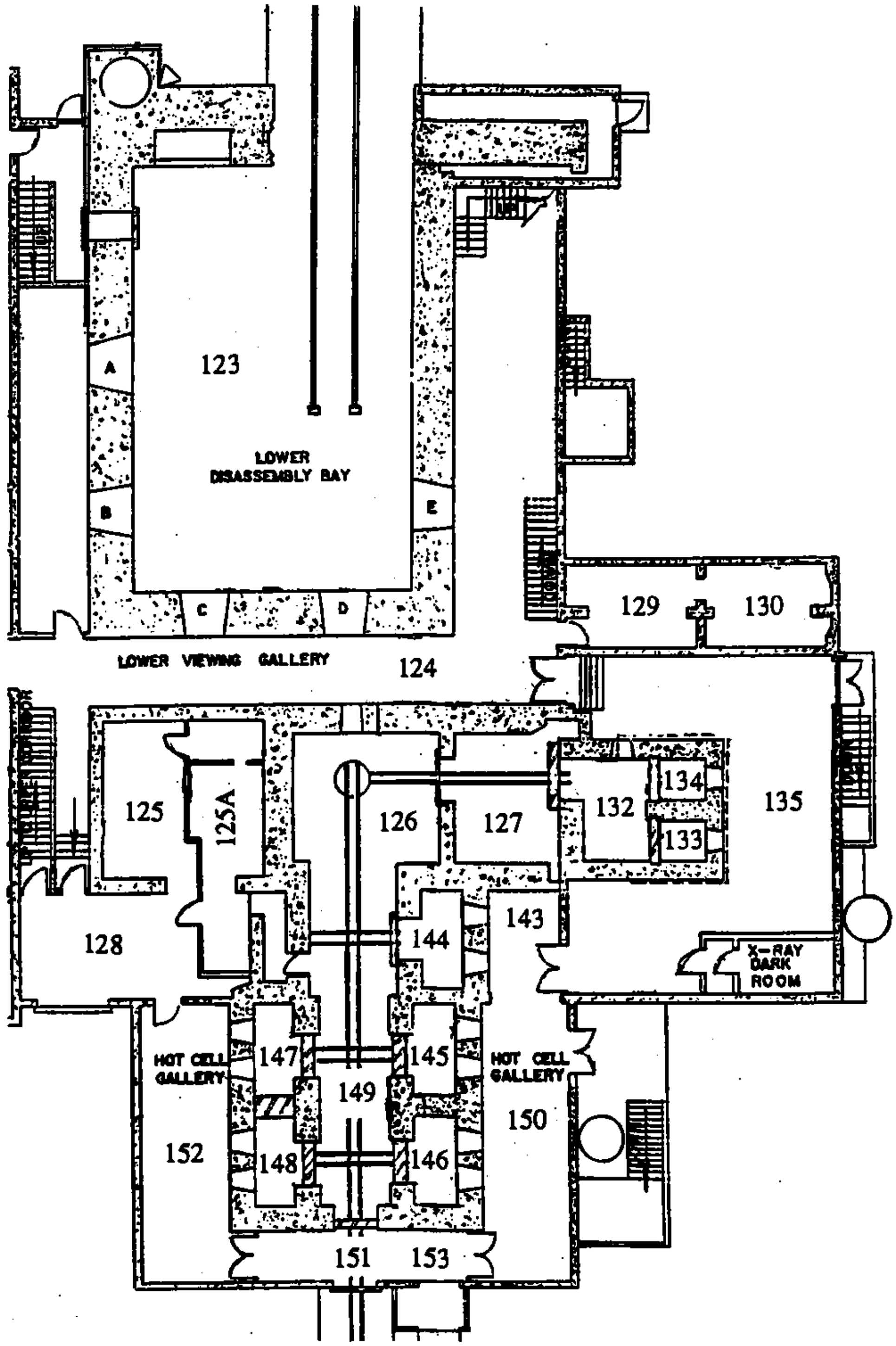


Figure 11. Floor 1 plan map of the hot disassembly area, with designated room numbers corresponding to the discussion of the text.

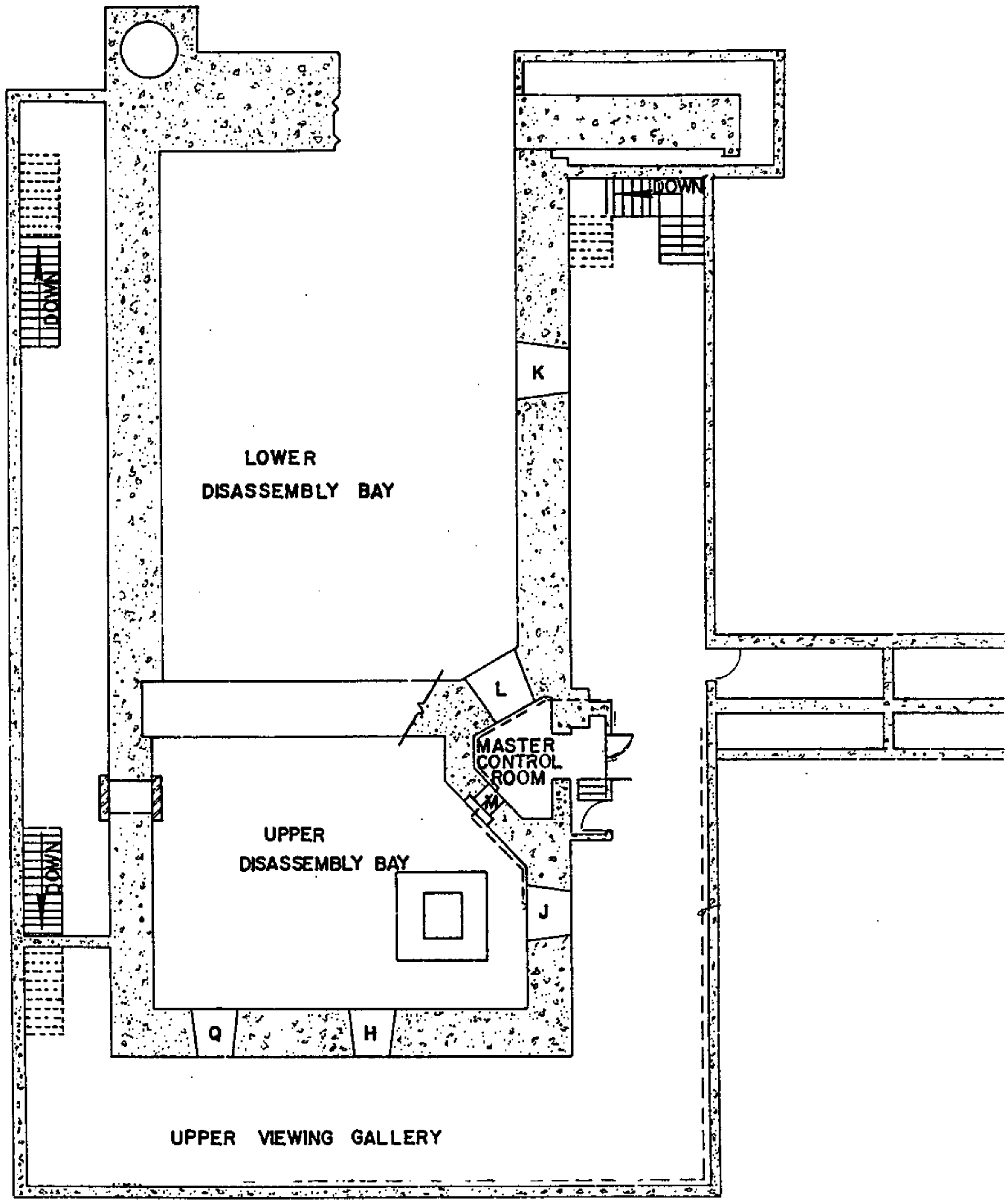


Figure 12. Floor 2 plan map of the hot disassembly area illustrating the upper and lower level disassembly bays and the surrounding gallery.